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Introduction to Physical Therapy
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Modern fighter aircraft employed by various nations in the world all have a system in place for the pilot to escape if problems arise with the aircraft in flight. This is known as the ejection system. While this allows the pilot to escape an aircraft, there are injuries that can result from ejection.

For an ejection from a fighter to be effective, it must propel approximately 400 pounds (pilot and seat) well clear of the aircraft to avoid the pilot striking the tail at high speed. In order to achieve this, great force must be used to propel both the seat and the pilot. In modern fighters this is achieved by firing rocket motors mounted on the bottom of the seat, which in turn propels the seat up rails on what is known as initial trajectory to safely clear the pilot of the aircraft. The force that is exerted on the pilot during the propulsion phase of the ejection can be anywhere from 2 G's (G is the force of gravity, 2 G's is twice the force of gravity) to 25 G's. This force is exerted on the pilot from the top down and is in addition to any G-forces that were being exerted at the time of ejection.

These downward G-forces are the primary cause the most common injury to fighter pilots who have to eject. This injury is known as spinal compression fracture. A physically fit individual can normally withstand around 9 G's of force on the body. During combat maneuvers, these G-forces are spread evenly over the entire body. In the ejection process, however, these forces are concentrated at the top of the axis of motion and push directly down along that axis. Spinal compression fractures occur when the anterior portions of the vertebrae are pushed together by some kind of force, in this case the force of gravity that is multiplied due to the inertia of the aircraft. The results of this injury can be severe sudden onset pain in the back (sometimes the onset of pain will be hours after the injury), shortened height, lack of feeling or strength in the legs, limited motion, and swelling over the fractured vertebrae. In severe cases paralysis may also result. In rare cases there may be no outward symptoms present.

In the event that symptoms are reported, first-aid measures should be taken. A person should be placed on a flat surface to be used as a backboard. An injured person should be

laid flat and log-rolled toward your body while the board is inserted underneath the person. At that point, the injured person should be gently rolled onto the board until help arrives. If a suitable object is not available to be used as a backboard, the injured person should be laid as flat as possible on his or her back.

The spinal column is made up of 24 vertebrae. The main section of each vertebra is made up of a large round structure called the vertebral body, which is on the anterior of each vertebra. Attached to each vertebral body is a bony ring, which surrounds the spinal cord. Between each vertebral body is a tissue known as the intervertebral disc, which provides shock absorption for the spinal column. In a spinal compression fracture, the vertebral bodies are pushed together with such force as to render protection from the intervertebral discs ineffective. In most cases of spinal compression fracture, only the anterior portions of the vertebral body are affected. In some severe cases, the posterior portions may be affected.

In most cases treatment of a spinal compression fracture does not involve surgery. The physician will generally order bed rest and may have the patient fitted with a brace in order to immobilize the spine during healing. In severe trauma cases, surgery may be necessary. Usually surgery is performed to remove any bone fragments that may have lodged into the spinal cord or surrounding muscles; however, this is only rarely necessary. In a posterior-located spinal compression fracture, however, treatment is usually directed by an orthopedist on a case-by-case basis.

Physical therapy for spinal compression fractures normally begins around 6 to 8 weeks following medical treatment. The patient normally feels chronic or acute pain during the healing time. Also, as the patient has had his or her activity limited during the healing process, there is a loss of endurance, strength, and muscle tone in the trunk of the body. Physical therapy therefore centers on pain reduction (or management) and strengthening of the trunk.

The primary consideration in therapy is to prevent flexion of the spine. Although by the time a patient enters therapy the bones are healed, they are still relatively weak. Patient education early during rehabilitation is key in preventing flexion of the spine. Examples of this include sitting with a lumbar support (to avoid sitting in flexed position) and

teaching the patient how to stand from a recumbent (laying on the back) position without flexing the spine.

Acute pain is normally managed through modalities such as moist heat and electrostimulation on the pain area. The patient will more than likely feel acute pain at the beginning of rehabilitation. More often the patient will feel chronic pain, as the muscles in the trunk will be weaker than before the injury. Again, heat and electrostimulation will help reduce the pain a patient feels, if only for a short while. Once the pain level has reached a point where activity can be tolerated, a program of active and passive extension exercises is indicated to strengthen the muscles in the lower back.

An active exercise that is commonly used for this is Prone Extension Progression and is commonly called the “Superman” exercise. This exercise begins with the patient lying flat on the stomach. The patient then will raise the one leg behind them along with the opposite arm. The patient will then hold this position for 3 to 5 seconds, release, and repeat with the other leg/arm combination. Another active exercise used for this is a variation of the “Superman” exercise called the Prone Extension Off Edge of Object. This exercise builds upon the “Superman” exercise. The patient is placed in the prone position on a chair with the legs and upper body hanging off the side. The patient, using arms as a support, can then raise both legs up and behind their body. Once the legs are fully extended, the patient can then flex their knees, which will help them pull their legs back even more than is possible keeping the legs straight. Another step in the exercise involves a partner (usually the therapist) holding the patient’s legs while the patient lifts his or her body to a prone position. This is normally done from a full table and care must be taken to ensure that the starting position is flexion-neutral.

As strength begins to build, more advanced exercises may be performed in treatment. An example of a more advanced exercise in strengthening the trunk of the body is the pelvic twist. In this exercise, the patient will lie flat on the back with their legs bent as if getting ready to perform abdominal crunches. The patient will then raise the pelvis up, hold the position, and then lower the pelvis back the floor. With this exercise it is key that the therapist ensure that the patient maintains a flexion-neutral posture throughout the motion.

Steps have been taken by the military to reduce the occurrence of spinal compression fracture. In aircraft prior to the F-16 Falcon, the back of the pilot's seat was completely vertical. This vertical posture contributed greatly to the occurrence of spinal compression fracture. Starting with the F-16, all fighter pilot seats are now reclined. This not only helps the pilot cope with high G-forces, it also reduces pressure on the spine in case of ejection, as the force of the propulsion is no longer directly on the spine. The military has also experimented with other types of ejection systems aside from the ejection seat. One example of this is the capsule ejection system found on the F-111.

There are other injuries that may occur with ejection. These include fractures of various bones resulting from windblast as well as abrasions. The pilot may also suffer injuries such as leg fractures when touching down from an ejection.

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